Department of Computer Science and Engineering

National Institute of Technology Srinagar

Hazratbal, Srinagar, Jammu and Kashmir - 190006, India

LAB RECORD

Course Name: Compiler Design [CST416]

Submitted by

Niyati Gupta

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Submitted to

DR TAUSEEF AYOUB SHAIKH

Department of Computer Science and Engineering

National Institute of Technology Srinagar

Hazratbal, Srinagar, Jammu and Kashmir – 190006, India

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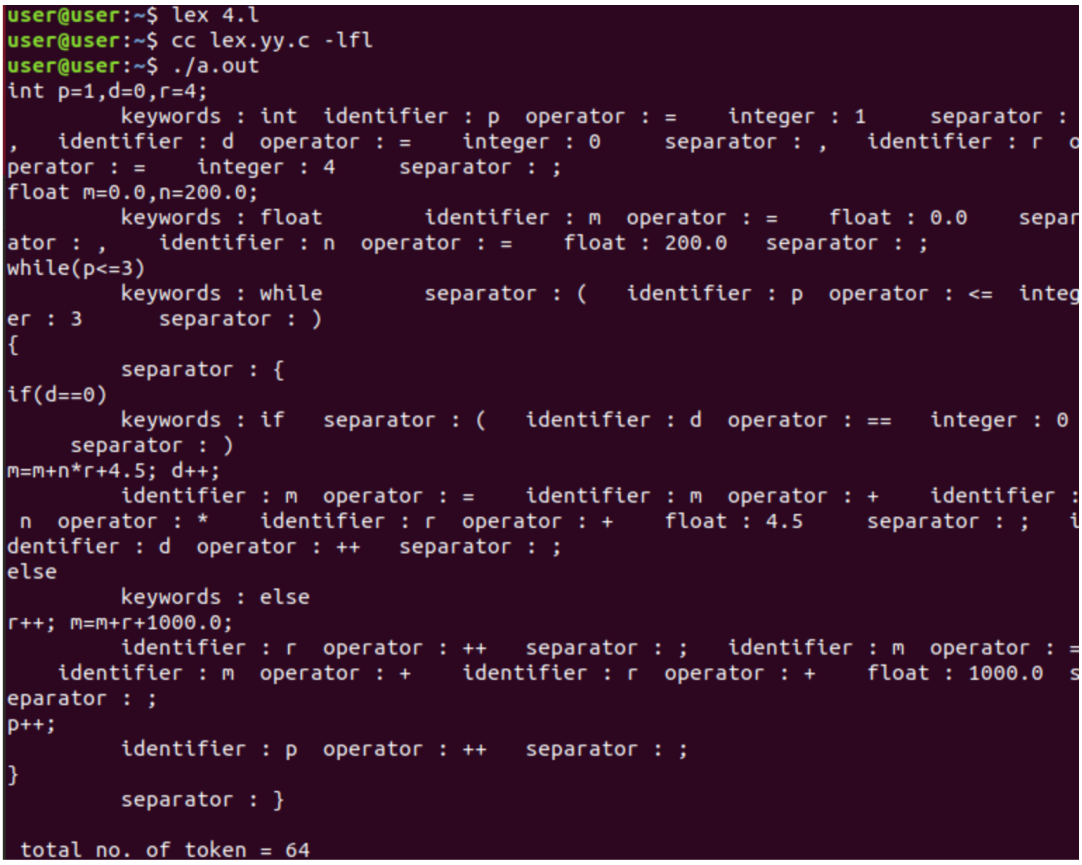
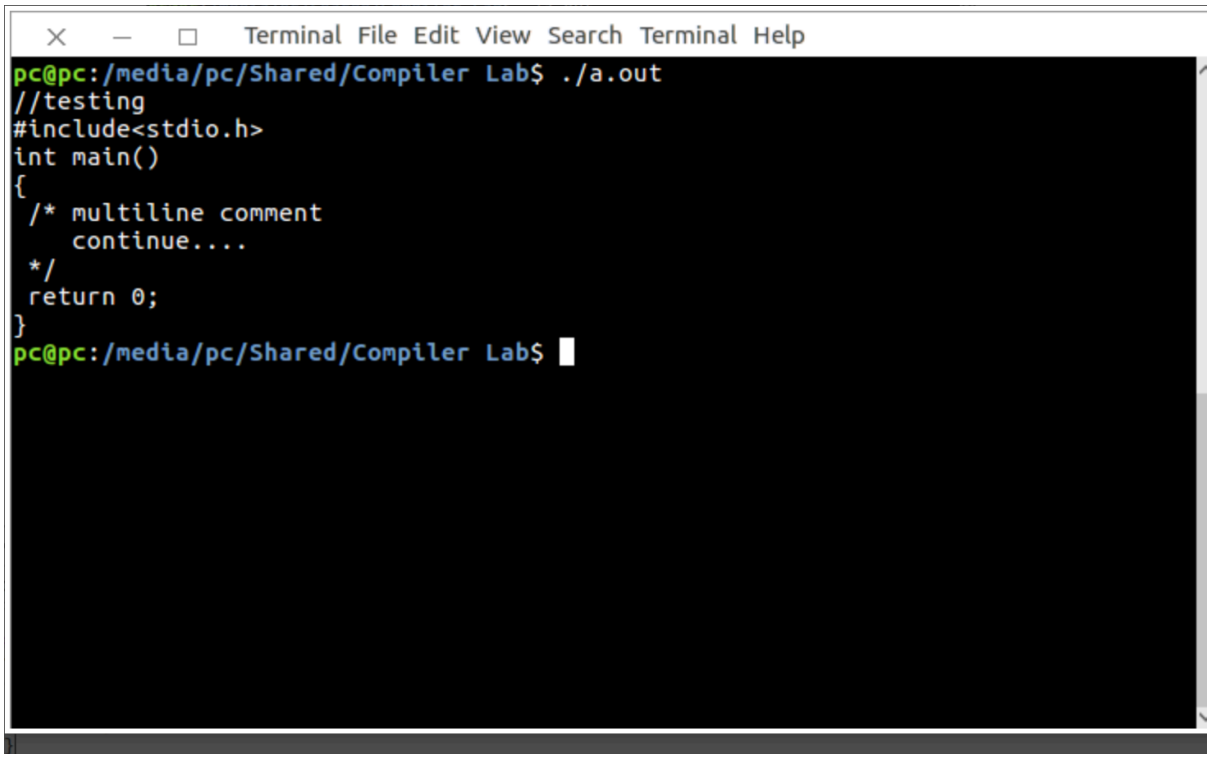
OUTPUT :



```
user@user:~$ lex 4.l
user@user:~$ cc lex.yy.c -lfl
user@user:~$ ./a.out
int p=1,d=0,r=4;
        keywords : int  identifier : p  operator : =    integer : 1     separator :
,   identifier : d  operator : =    integer : 0     separator : ,   identifier : r  o
perator : =    integer : 4     separator : ;
float m=0.0,n=200.0;
        keywords : float        identifier : m  operator : =    float : 0.0    separ
ator : ,    identifier : n  operator : =    float : 200.0   separator : ;
while(p<=3)
        keywords : while        separator : (   identifier : p  operator : <=  integ
er : 3      separator : )
{
        separator : {
if(d==0)
        keywords : if   separator : (   identifier : d  operator : ==   integer : 0
     separator : )
m=m+n*r+4.5; d++;
        identifier : m  operator : =    identifier : m  operator : +    identifier :
 n  operator : *    identifier : r  operator : +    float : 4.5     separator : ;   i
dentifier : d  operator : ++   separator : ;
else
        keywords : else
r++; m=m+r+1000.0;
        identifier : r  operator : ++   separator : ;   identifier : m  operator : =
    identifier : m  operator : +    identifier : r  operator : +    float : 1000.0  s
eparator : ;
p++;
        identifier : p  operator : ++   separator : ;
}
        separator : }

 total no. of token = 64
```

OUTPUT :


Terminal File Edit View Search Terminal Help
pc@pc:/media/pc/Shared/Compiler Lab$ ./a.out
//testing
#include<stdio.h>
int main()
{
/* multiline comment
continue....
*/
return 0;
}
pc@pc:/media/pc/Shared/Compiler Lab$

LAB: 03

Aim: Write a program to convert Non-Deterministic Grammar to Deterministic Grammar

Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#define MAX_LEN 100
char NFA_FILE[MAX_LEN];
char buffer[MAX_LEN];
int zz = 0;
// Structure to store DFA states and their
// status ( i.e new entry or already present)
struct DFA {
  char *states;
  int count;
} dfa;
int last_index = 0;
FILE *fp;
int symbols;
/* reset the hash map*/
void reset(int ar[], int size) {
  int i;
  // reset all the values of
  // the mapping array to zero
  for (i = 0; i < size; i++) {
    ar[i] = 0;
  }
}
// Check which States are present in the e-closure
```

```
/* map the states of NFA to a hash set*/
void check(int ar[], char S[]) {
  int i, j;
  // To parse the individual states of NFA
  int len = strlen(S);
  for (i = 0; i < len; i++) {
    // Set hash map for the position
    // of the states which is found
    j = ((int)(S[i]) - 65);
    ar[j]++;
  }
}
// To find new Closure States
void state(int ar[], int size, char S[]) {
  int j, k = 0;

  // Combine multiple states of NFA
  // to create new states of DFA
  for (j = 0; j < size; j++) {
    if (ar[j] != 0)
      S[k++] = (char)(65 + j);
  }
  // mark the end of the state
  S[k] = '\0';
}
// To pick the next closure from closure set
int closure(int ar[], int size) {
  int i;
  // check new closure is present or not
  for (i = 0; i < size; i++) {
    if (ar[i] == 1)
      return i;
```

```
  }
  return (100);
}
// Check new DFA states can be
// entered in DFA table or not
int indexing(struct DFA *dfa) {
  int i;
  for (i = 0; i < last_index; i++) {
    if (dfa[i].count == 0)
      return 1;
  }
  return -1;
}
/* To Display epsilon closure*/
void Display_closure(int states, int closure_ar[],
                     char *closure_table[],
                     char *NFA_TABLE[][symbols + 1],
                     char *DFA_TABLE[][symbols]) {
  int i;
  for (i = 0; i < states; i++) {
    reset(closure_ar, states);
    closure_ar[i] = 2;

    // to neglect blank entry
    if (strcmp(&NFA_TABLE[i][symbols], "-") != 0) {
  // copy the NFA transition state to buffer
      strcpy(buffer, &NFA_TABLE[i][symbols]);
      check(closure_ar, buffer);
      int z = closure(closure_ar, states);
      // till closure get completely saturated
      while (z != 100)
      {
```

```
      if (strcmp(&NFA_TABLE[z][symbols], "-") != 0) {
        strcpy(buffer, &NFA_TABLE[z][symbols]);

        // call the check function
        check(closure_ar, buffer);
      }
      closure_ar[z]++;
      z = closure(closure_ar, states);
    }
  }
  // print the e closure for every states of NFA
  printf("\n e-Closure (%c) :\t", (char)(65 + i));
  bzero((void *)buffer, MAX_LEN);
  state(closure_ar, states, buffer);
  strcpy(&closure_table[i], buffer);
  printf("%s\n", &closure_table[i]);
 }
}

/* To check New States in DFA */
int new_states(struct DFA *dfa, char S[]) {
 int i;

 // To check the current state is already
 // being used as a DFA state or not in
 // DFA transition table
 for (i = 0; i < last_index; i++) {
  if (strcmp(&dfa[i].states, S) == 0)
   return 0;
 }
 // push the new
 strcpy(&dfa[last_index++].states, S);
```

```
  // set the count for new states entered
  // to zero
  dfa[last_index - 1].count = 0;
  return 1;
}
// Transition function from NFA to DFA
// (generally union of closure operation )
void trans(char S[], int M, char *clsr_t[], int st,
            char *NFT[][symbols + 1], char TB[]) {
  int len = strlen(S);
  int i, j, k, g;
  int arr[st];
  int sz;
  reset(arr, st);
  char temp[MAX_LEN], temp2[MAX_LEN];
  char *buff;
  // Transition function from NFA to DFA
  for (i = 0; i < len; i++) {
    j = ((int)(S[i] - 65));
    strcpy(temp, &NFT[j][M]);
if (strcmp(temp, "-") != 0) {
      sz = strlen(temp);
      g = 0;
      while (g < sz) {
        k = ((int)(temp[g] - 65));
        strcpy(temp2, &clsr_t[k]);
        check(arr, temp2);
        g++;
      }
    }
  }
  bzero((void *)temp, MAX_LEN);
```

```
  state(arr, st, temp);
  if (temp[0] != '\0') {
    strcpy(TB, temp);
  } else
    strcpy(TB, "-");
}
/* Display DFA transition state table*/
void Display_DFA(int last_index, struct DFA *dfa_states,
                 char *DFA_TABLE[][symbols]) {
  int i, j;
  printf("\n\n*************************************************************\n\n");
  printf("\t\t DFA TRANSITION STATE TABLE \t\t \n\n");
  printf("\n STATES OF DFA :\t\t");
  for (i = 1; i < last_index; i++)
    printf("%s, ", &dfa_states[i].states);
  printf("\n");
  printf("\n GIVEN SYMBOLS FOR DFA: \t");
  for (i = 0; i < symbols; i++)
    printf("%d, ", i);
  printf("\n\n");
  printf("STATES\t");
  for (i = 0; i < symbols; i++)
    printf("|%d\t", i);
  printf("\n");
  // display the DFA transition state table
  printf("--------+----------------------\n");
  for (i = 0; i < zz; i++) {
    printf("%s\t", &dfa_states[i + 1].states);
    for (j = 0; j < symbols; j++) {
      printf("|%s \t", &DFA_TABLE[i][j]);
    }
    printf("\n");
```

```
  }
}
// Driver Code
int main() {
  int i, j, states;
  char T_buf[MAX_LEN];
  // creating an array dfa structures
  struct DFA *dfa_states = malloc(MAX_LEN * (sizeof(dfa)));
  states = 6, symbols = 2;
  printf("\n STATES OF NFA :\t\t");
  for (i = 0; i < states; i++)
    printf("%c, ", (char)(65 + i));
  printf("\n");
  printf("\n GIVEN SYMBOLS FOR NFA: \t");

  for (i = 0; i < symbols; i++)
    printf("%d, ", i);
  printf("eps");
  printf("\n\n");
  char *NFA_TABLE[states][symbols + 1];
  // Hard coded input for NFA table
  char *DFA_TABLE[MAX_LEN][symbols];
  strcpy(&NFA_TABLE[0][0], "FC");
  strcpy(&NFA_TABLE[0][1], "-");
  strcpy(&NFA_TABLE[0][2], "BF");
  strcpy(&NFA_TABLE[1][0], "-");
  strcpy(&NFA_TABLE[1][1], "C");
  strcpy(&NFA_TABLE[1][2], "-");
  strcpy(&NFA_TABLE[2][0], "-");
  strcpy(&NFA_TABLE[2][1], "-");
  strcpy(&NFA_TABLE[2][2], "D");
  strcpy(&NFA_TABLE[3][0], "E");
```

```
strcpy(&NFA_TABLE[3][1], "A");
strcpy(&NFA_TABLE[3][2], "-");
strcpy(&NFA_TABLE[4][0], "A");
strcpy(&NFA_TABLE[4][1], "-");
strcpy(&NFA_TABLE[4][2], "BF");
strcpy(&NFA_TABLE[5][0], "-");
strcpy(&NFA_TABLE[5][1], "-");
strcpy(&NFA_TABLE[5][2], "-");
printf("\n NFA STATE TRANSITION TABLE \n\n\n");
printf("STATES\t");
for (i = 0; i < symbols; i++)
  printf("|%d\t", i);
printf("eps\n");
// Displaying the matrix of NFA transition table
printf("--------+-----------------------------------\n");
for (i = 0; i < states; i++) {
  printf("%c\t", (char)(65 + i));
  for (j = 0; j <= symbols; j++) {
    printf("|%s \t", &NFA_TABLE[i][j]);
  }
  printf("\n");
}
int closure_ar[states];
char *closure_table[states];
Display_closure(states, closure_ar, closure_table, NFA_TABLE, DFA_TABLE);
strcpy(&dfa_states[last_index++].states, "-");
dfa_states[last_index - 1].count = 1;
bzero((void *)buffer, MAX_LEN);
strcpy(buffer, &closure_table[0]);
strcpy(&dfa_states[last_index++].states, buffer);
int Sm = 1, ind = 1;
int start_index = 1;
```

```
 // Filling up the DFA table with transition values
 // Till new states can be entered in DFA table
 while (ind != -1) {
   dfa_states[start_index].count = 1;
   Sm = 0;
   for (i = 0; i < symbols; i++) {
     trans(buffer, i, closure_table, states, NFA_TABLE, T_buf);
// storing the new DFA state in buffer
strcpy(&DFA_TABLE[zz][i], T_buf);
     // parameter to control new states
     Sm = Sm + new_states(dfa_states, T_buf);
   }
   ind = indexing(dfa_states);
   if (ind != -1)
     strcpy(buffer, &dfa_states[++start_index].states);
   zz++;
 }
 // display the DFA TABLE
 Display_DFA(last_index, dfa_states, DFA_TABLE);

 return 0;
}
```

OUTPUT :

```
 STATES OF NFA :                A, B, C, D, E, F,

 GIVEN SYMBOLS FOR NFA:         0, 1, eps


 NFA STATE TRANSITION TABLE


STATES  |0      |1      eps
--------+-------------------------------------
A       |FC     |-      |BF
B       |-      |C      |-
C       |-      |-      |D
D       |E      |A      |-
E       |A      |-      |BF
F       |-      |-      |-

 e-Closure (A) :        ABF

 e-Closure (B) :        B

 e-Closure (C) :        CD

 e-Closure (D) :        D

 e-Closure (E) :        BEF

 e-Closure (F) :        F


**********************************************************

                DFA TRANSITION STATE TABLE


 STATES OF DFA :                ABF, CDF, CD, BEF,

 GIVEN SYMBOLS FOR DFA:         0, 1,

STATES  |0      |1
--------+----------------------
ABF     |CDF    |CD
CDF     |BEF    |ABF
CD      |BEF    |ABF
BEF     |ABF    |CD
(base) nivatiqupta@Maccy 2020BCSE073 %
```

LAB: 04

Aim: Write a program to calculate First and Follow of a given LL(1) grammar.

Code:

```
#include <ctype.h>
#include <stdio.h>
#include <string.h>
// Functions to calculate Follow
void followfirst(char, int, int);
void follow(char c);
// Function to calculate First
void findfirst(char, int, int);
int count, n = 0;
// Stores the final result
// of the First Sets
char calc_first[10][100];
// Stores the final result
// of the Follow Sets
char calc_follow[10][100];
int m = 0;
// Stores the production rules
char production[10][10];
char f[10], first[10];
int k;
char ck;
int e;
int main(int argc, char** argv)
{
   int jm = 0;
   int km = 0;
   int i, choice;
   char c, ch;
   count = 8;
```

```
    // The Input grammar
    strcpy(production[0], "X=TnS");
    strcpy(production[1], "X=Rm");
    strcpy(production[2], "T=q");
    strcpy(production[3], "T=#");
    strcpy(production[4], "S=p");
    strcpy(production[5], "S=#");
    strcpy(production[6], "R=om");
    strcpy(production[7], "R=ST");
    int kay;
    char done[count];
    int ptr = -1;
    // Initializing the calc_first array
    for (k = 0; k < count; k++) {
        for (kay = 0; kay < 100; kay++) {
            calc_first[k][kay] = '!';
        }
    }
    int point1 = 0, point2, xxx;
    for (k = 0; k < count; k++) {
        c = production[k][0];
        point2 = 0;
        xxx = 0;
        // Checking if First of c has
        // already been calculated
        for (kay = 0; kay <= ptr; kay++)
if (c == done[kay])
                xxx = 1;
        if (xxx == 1)
            continue;
        // Function call
        findfirst(c, 0, 0);
        ptr += 1;
```

```
    // Adding c to the calculated list
    done[ptr] = c;
    printf("\n First(%c) = { ", c);
    calc_first[point1][point2++] = c;
    // Printing the First Sets of the grammar
    for (i = 0 + jm; i < n; i++) {
      int lark = 0, chk = 0;
      for (lark = 0; lark < point2; lark++) {
        if (first[i] == calc_first[point1][lark]) {
          chk = 1;
          break;
        }
      }
      if (chk == 0) {
        printf("%c, ", first[i]);
        calc_first[point1][point2++] = first[i];
      }
    }
    printf("}\n");
    jm = n;
    point1++;
  }
printf("\n");
 printf("-----------------------------------------------"
      "\n\n");
 char donee[count];
 ptr = -1;
 // Initializing the calc_follow array
 for (k = 0; k < count; k++) {
    for (kay = 0; kay < 100; kay++) {
      calc_follow[k][kay] = '!';
    }
 }
```

```
point1 = 0;
int land = 0;
for (e = 0; e < count; e++) {
   ck = production[e][0];
   point2 = 0;
   xxx = 0;
   // Checking if Follow of ck
   // has already been calculated
   for (kay = 0; kay <= ptr; kay++)
      if (ck == donee[kay])
         xxx = 1;
   if (xxx == 1)
      continue;
   land += 1;
   // Function call
   follow(ck);
   ptr += 1;
   // Adding ck to the calculated list
   donee[ptr] = ck;
   printf(" Follow(%c) = { ", ck);
   calc_follow[point1][point2++] = ck;
   // Printing the Follow Sets of the grammar
   for (i = 0 + km; i < m; i++) {
      int lark = 0, chk = 0;
      for (lark = 0; lark < point2; lark++) {
         if (f[i] == calc_follow[point1][lark]) {
            chk = 1;
            break;
         }
      }
      if (chk == 0) {
         printf("%c, ", f[i]);
         calc_follow[point1][point2++] = f[i];
```

```
            }
        }
        printf(" }\n\n");
        km = m;
        point1++;
    }
}
void follow(char c)
{
    int i, j;
    // Adding "$" to the follow
    // set of the start symbol
    if (production[0][0] == c) {
        f[m++] = '$'; }
    for (i = 0; i < 10; i++) {
        for (j = 2; j < 10; j++) {
            if (production[i][j] == c) {
                if (production[i][j + 1] != '\0') {
                    // Calculate the first of the next
                    // Non-Terminal in the production
                    followfirst(production[i][j + 1], i,
                                (j + 2));
                }
                if (production[i][j + 1] == '\0'
                    && c != production[i][0]) {
                    // Calculate the follow of the
                    // Non-Terminal in the L.H.S. of the
                    // production
                    follow(production[i][0]);
                }
            }
        }
    }
```

```
}
void findfirst(char c, int q1, int q2)
{
    int j;
    // The case where we
    // encounter a Terminal
    if (!(isupper(c))) {
        first[n++] = c;
    }
    for (j = 0; j < count; j++) {
        if (production[j][0] == c) {
            if (production[j][2] == '#') {
                if (production[q1][q2] == '\0')
                    first[n++] = '#';
                else if (production[q1][q2] != '\0'
                        && (q1 != 0 || q2 != 0)) {
                    // Recursion to calculate First of New
                    // Non-Terminal we encounter after
                    // epsilon
                    findfirst(production[q1][q2], q1,
                            (q2 + 1));
                }
                else
                    first[n++] = '#';
            }
            else if (!isupper(production[j][2])) {
                first[n++] = production[j][2];
            }
            else {
                // Recursion to calculate First of
                // New Non-Terminal we encounter
                // at the beginning
                findfirst(production[j][2], j, 3);
```

```
        }
      }
   }
}
void followfirst(char c, int c1, int c2)
{   int k;
   // The case where we encounter
   // a Terminal
   if (!(isupper(c)))
      f[m++] = c;
   else {
      int i = 0, j = 1;
      for (i = 0; i < count; i++) {
         if (calc_first[i][0] == c)
            break;
      }       // Including the First set of the
      // Non-Terminal in the Follow of
      // the original query
      while (calc_first[i][j] != '!') {
         if (calc_first[i][j] != '#') {
            f[m++] = calc_first[i][j];
         }
         else {
            if (production[c1][c2] == '\0') {
               // Case where we reach the
               // end of a production
               follow(production[c1][0]);
            } else {
               // Recursion to the next symbol
               // in case we encounter a "#"
               followfirst(production[c1][c2], c1,
                           c2 + 1);
            }   }j++;}}}
```

Output:

```
(base) niyatigupta@Maccy 2020BCSE073 % cd "/Users/niyatigupta/Desktop/2020BCSE073/" && gcc b.c -o b && "/Users/niyatigupta/Desktop/2020BCSE073/"b
 First(X) = { q, n, o, p, #, }
 First(T) = { q, #, }
 First(S) = { p, #, }
 First(R) = { o, p, q, #, }
--------------------------------------------
 Follow(X) = { $,  }
 Follow(T) = { n, m,  }
 Follow(S) = { $, q, m,  }
 Follow(R) = { m,  }
(base) niyatigupta@Maccy 2020BCSE073 %
```

LAB: 05

Aim: Write a program to construct LL(1) parsing table for LL(1) grammar and validate the input string .

Code:

```
#include<stdio.h>
#include<ctype.h>
#include<string.h>
void followfirst(char , int , int);
void findfirst(char , int , int);
void follow(char c);
int count,n=0;
char calc_first[10][100];
char calc_follow[10][100];
int m=0;
char production[10][10], first[10];
char f[10];
int k;
char ck;
int e;
int main(int argc,char **argv){
        int jm =0;
        int km=0;
        int i,choice;
        char c,ch;
        printf("How many productions ? :");
        scanf("%d",&count);
        printf("\nEnter %d productions in form A=B where A and B are grammar symbols :
\n\n",count);
        for(i=0;i<count;i++){
                scanf("%s%c",production[i],&ch);
        }
```

```
int kay;
char done[count];
int ptr = -1;
for(k=0;k<count;k++){
        for(kay=0;kay<100;kay++){
                calc_first[k][kay] = '!';
        }
}
int point1 = 0,point2,xxx;
for(k=0;k<count;k++){
        c=production[k][0];
        point2 = 0;
        xxx = 0;
        for(kay = 0; kay <= ptr; kay++)
                if(c == done[kay])          xxx = 1;
        if (xxx == 1)       continue;
        findfirst(c,0,0) ;
        ptr+=1 ;
        done[ptr] = c;
        printf("\n First(%c)= { ",c);
        calc_first[point1][point2++] = c;
        for(i=0+jm;i<n;i++){
                int lark = 0,chk = 0;
                for(lark=0;lark<point2;lark++){
                        if (first[i] == calc_first[point1][lark]){
                                chk = 1,  break;
                        }
                }
                if(chk == 0){
                        printf("%c, ",first[i]);
                        calc_first[point1][point2++] = first[i];
                }}
```

```
            printf("}\n");
            jm=n;
            point1++;}
printf("\n");
printf("----------------------------------------------\n\n");
char donee[count];
ptr = -1;
for(k=0;k<count;k++){
            for(kay=0;kay<100;kay++){
                        calc_follow[k][kay] = '!';
            }
}           point1 = 0;
int land = 0 ;
for(e=0;e<count;e++){
            ck=production[e][0];
            point2 = 0;
            xxx = 0;
            for(kay = 0; kay <= ptr; kay++)
                        if(ck == donee[kay])       xxx = 1;
            if (xxx == 1)       continue;
            land += 1;
            follow(ck);
            ptr+=1;
            donee[ptr] = ck;
            printf(" Follow(%c) = { ",ck);
            calc_follow[point1][point2++] = ck;
            for(i=0+km;i<m;i++){
                        int lark = 0,chk = 0;
                        for(lark=0;lark<point2;lark++){
                                    if (f[i] == calc_follow[point1][lark]){
                                                chk = 1;
                                                break;
```

```
                        }
                    }
                    if(chk == 0){
                        printf("%c, ",f[i]);
                        calc_follow[point1][point2++] = f[i];
                    }
                }
                printf(" }\n\n");
                km=m;
                point1++;
            }
            char ter[10];
            for(k=0;k<10;k++){
                ter[k] = '!';
            }
            int ap,vp,sid = 0;
            for(k=0;k<count;k++){
                for(kay=0;kay<count;kay++){
                    if(!isupper(production[k][kay]) && production[k][kay]!= '#' && production[k]
[kay] != '=' && production[k][kay] != '\0'){
                        vp = 0;
                        for(ap = 0;ap < sid; ap++){
                            if(production[k][kay] == ter[ap]){
                                vp = 1;
                                break;
                            }
                        }
                        if(vp == 0){
                            ter[sid] = production[k][kay];
                            sid ++;
                        }
                    }
```

```
                }
        }
        ter[sid] = '$';
        sid++;
        printf("\n\t\t\t\t\t\t\t The LL(1) Parsing Table for the above grammer :-");
        printf("\n\t\t\t\t\t\t\t^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^^\n");

printf("\n\t\t\t==========================================================================
==========================================\n");
        printf("\t\t\t\t|\t");
        for(ap = 0;ap < sid; ap++){
                printf("%c\t\t",ter[ap]);
        }

printf("\n\t\t\t==========================================================================
==========================================\n");
        char first_prod[count][sid];
        for(ap=0;ap<count;ap++){
                int destiny = 0;
                k = 2;
                int ct = 0;
                char tem[100];
                while(production[ap][k] != '\0'){
                        if(!isupper(production[ap][k])){
                                tem[ct++] = production[ap][k];
                                tem[ct++] = '_';
                                tem[ct++] = '\0';
                                k++;
                                break;
                        }
                        else{
                                int zap=0;
                                int tuna = 0;
```

```
                        for(zap=0;zap<count;zap++){
                                if(calc_first[zap][0] == production[ap][k]){
                                        for(tuna=1;tuna<100;tuna++){
                                                if(calc_first[zap][tuna] != '!'){
                                                        tem[ct++] = calc_first[zap][tuna];
                                                }
                                                else    break;
                                        }       break;
                                }}
                        tem[ct++] = '_';
                }k++;
        }
        int zap = 0,tuna;
        for(tuna = 0;tuna<ct;tuna++){
                if(tem[tuna] == '#'){
                        zap = 1;
                }else if(tem[tuna] == '_'){
                        if(zap == 1)      zap = 0;
                        else    break;
                }else   first_prod[ap][destiny++] = tem[tuna];
        }
}       char table[land][sid+1];
ptr = -1 ;
for(ap = 0; ap < land ; ap++){
        for(kay = 0; kay < (sid + 1) ; kay++){
                table[ap][kay] = '!';
        }
}
for(ap = 0; ap < count ; ap++){
        ck = production[ap][0];
        xxx = 0;
        for(kay = 0; kay <= ptr; kay++)
```

```
                if(ck == table[kay][0])xxx = 1;
        if (xxx == 1)       continue;
        else{
                ptr = ptr + 1;
                table[ptr][0] = ck;
        }
}
for(ap = 0; ap < count ; ap++){
        int tuna = 0;
        while(first_prod[ap][tuna] != '\0'){
                int to,ni=0;
                for(to=0;to<sid;to++){
                        if(first_prod[ap][tuna] == ter[to])          ni = 1;
                }
                if(ni == 1){
                        char xz = production[ap][0];
                        int cz=0;
                        while(table[cz][0] != xz){
                                cz = cz + 1;
                        }
                        int vz=0;
                        while(ter[vz] != first_prod[ap][tuna]){
                                vz = vz + 1;
                        }
                        table[cz][vz+1] = (char)(ap + 65);
                }
                tuna++;
        }
}
for(k=0;k<sid;k++){
        for(kay=0;kay<100;kay++){
                if(calc_first[k][kay] == '!')          break ;
```

```
                else if(calc_first[k][kay] == '#'){
                        int fz = 1;
                        while(calc_follow[k][fz] != '!'){
                                char xz = production[k][0];
                                int cz=0;
                                while(table[cz][0] != xz){
                                        cz = cz + 1;
                                }
                                int vz=0;
                                while(ter[vz] != calc_follow[k][fz]){
                                        vz = vz + 1;
                                }
                                table[k][vz+1] = '#';
                                fz++;
                        }       break;
                }
        }
}
for(ap = 0; ap < land ; ap++){
        printf("\t\t\t   %c\t|\t",table[ap][0]);
        for(kay = 1; kay < (sid + 1) ; kay++){
                if(table[ap][kay] == '!')
                        printf("\t\t");
                else if(table[ap][kay] == '#')
                        printf("%c=#\t\t",table[ap][0]);
                else{
                        int mum = (int)(table[ap][kay]);
                        mum -= 65;
                        printf("%s\t\t",production[mum]);
                }
        }       printf("\n");
```

```
printf("\t\t\t----------------------------------------------------------------------------------------------------------
");
                printf("\n");
        }
        int j;
        printf("\n\nPlease enter the desired INPUT STRING = ");
        char input[100];
        scanf("%s%c",input,&ch);

printf("\n\t\t\t\t\t==========================================================================
========\n");
        printf("\t\t\t\t\t\tStack\t\t\tInput\t\t\tAction");

printf("\n\t\t\t\t\t==========================================================================
========\n");
        int i_ptr = 0,s_ptr = 1;
        char stack[100];
        stack[0] = '$';
        stack[1] = table[0][0];
        while(s_ptr != -1){
                printf("\t\t\t\t\t\t");
                int vamp = 0;
                for(vamp=0;vamp<=s_ptr;vamp++){
                        printf("%c",stack[vamp]);
                }
                printf("\t\t\t");
                vamp = i_ptr;
                while(input[vamp] != '\0'){
                        printf("%c",input[vamp]);
                        vamp++;
                }
                printf("\t\t\t");
                char her = input[i_ptr];
```

```
char him = stack[s_ptr];
s_ptr--;
if(!isupper(him)){
        if(her == him){
                i_ptr++;
                printf("POP ACTION\n");
        }
        else{
                printf("\nString Not Accepted by LL(1) Parser !!\n");
                exit(0);
        }
}else{
        for(i=0;i<sid;i++){
                if(ter[i] == her)
                        break;
        }
        char produ[100];
        for(j=0;j<land;j++){
                if(him == table[j][0]){
                        if (table[j][i+1] == '#'){
                                printf("%c=#\n",table[j][0]);
                                produ[0] = '#';
                                produ[1] = '\0';
                        }
                        else if(table[j][i+1] != '!'){
                                int mum = (int)(table[j][i+1]);
                                mum -= 65;
                                strcpy(produ,production[mum]);
                                printf("%s\n",produ);
                        }else{
                                printf("\nString Not Accepted by LL(1) Parser !!\n");
                                exit(0);
```

```
                                        }
                                }
                        }
                        int le = strlen(produ);
                        le = le - 1;
                        if(le == 0){
                                continue;
                        }
                        for(j=le;j>=2;j--){
                                s_ptr++;
                                stack[s_ptr] = produ[j];
                        }
                }
        }

printf("\n\t\t\t==========================================================================
================================================\n");
        if (input[i_ptr] == '\0'){
                printf("\t\t\t\t\t\t\t\tYOUR STRING HAS BEEN ACCEPTED !!\n");
        }else
                printf("\n\t\t\t\t\t\t\t\tYOUR STRING HAS BEEN REJECTED !!\n");

printf("\t\t\t==========================================================================
================================================\n");
}
void follow(char c){
        int i ,j;
        if(production[0][0]==c){
                f[m++]='$';
        }
        for(i=0;i<10;i++){
                for(j=2;j<10;j++){
                        if(production[i][j]==c){
```

```
                        if(production[i][j+1]!='\0'){
                                followfirst(production[i][j+1],i,(j+2));
                        }if(production[i][j+1]=='\0'&&c!=production[i][0]){
                        follow(production[i][0]);
                        }
                        }
                }
        }
}
void findfirst(char c ,int q1 , int q2)
{
        int j;
        if(!(isupper(c)))
                first[n++]=c;
        for(j=0;j<count;j++){
                if(production[j][0]==c)
                {
                        if(production[j][2]=='#'){
                                if(production[q1][q2] == '\0')
                                        first[n++]='#';
                                else if(production[q1][q2] != '\0' && (q1 != 0 || q2 != 0))
                                {
                                        findfirst(production[q1][q2], q1, (q2+1));
                                }
                                else    first[n++]='#';
                        }
                        else if(!isupper(production[j][2]))
                                first[n++]=production[j][2] ;
                        else    findfirst(production[j][2], j, 3);
                }
        }
}
```

```
void followfirst(char c, int c1 , int c2){
   int k;
   if(!(isupper(c)))
                    f[m++]=c;
          else{
                    int i=0,j=1;
                    for(i=0;i<count;i++)
                    {
                              if(calc_first[i][0] == c)
                                        break;
                    }
                    while(calc_first[i][j] != '!')
                    {
                              if(calc_first[i][j] != '#'){
                                        f[m++] = calc_first[i][j];
                              }
                              else{
                                        if(production[c1][c2] == '\0')
                                                  follow(production[c1][0]);
                                        else      followfirst(production[c1][c2],c1,c2+1);
                              }
                              j++;
                    }
          }
}
```

Output:

```
(base) niyatigupta@Maccy 2020BCSE073 % cd "/Users/niyatigupta/Desktop/2020BCSE073/" && gcc d.c -o d && "/Users/niyatigupta/Desktop/2020BCSE073/"d
How many productions ? :8

Enter 8 productions in form A=B where A and B are grammar symbols :

E=TR
R=+TR
R=#
T=FY
Y=*FY
Y=#
F=(E)
F=i

 First(E)= { (, i, }

 First(R)= { +, #, }

 First(T)= { (, i, }

 First(Y)= { *, #, }

 First(F)= { (, i, }

------------------------------------------

 Follow(E) = { $, ),  }

 Follow(R) = { $, ),  }

 Follow(T) = { +, $, ),  }

 Follow(Y) = { +, $, ),  }

 Follow(F) = { *, +, $, ), (, i,  }

                                                The LL(1) Parsing Table for the above grammer :-

                        ================================================================================================================
                                |       +               $               (               i               *               )               $
                        ================================================================================================================
                           +    |                                       +$(i+
                        ----------------------------------------------------------------------------------------------------------------
                           R    |       R=+TR           R=#                                                             R=#
                        ----------------------------------------------------------------------------------------------------------------
                           T    |                                       T=FY            T=FY
                        ----------------------------------------------------------------------------------------------------------------
                           Y    |       Y=#             Y=#                                             Y=*FY           Y=#
                        ----------------------------------------------------------------------------------------------------------------
                           F    |                                       F=(E)           F=i
                        ----------------------------------------------------------------------------------------------------------------
```

```
 Please enter the desired INPUT STRING = i+i*i$

                                    ========================================================================
                                            Stack                   Input                   Action
                                    ========================================================================
                                            $+                      i+i*i$
 String Not Accepted by LL(1) Parser !!
                                            $                       i+i*i$
 String Not Accepted by LL(1) Parser !!

                        ================================================================================================================

                                                        YOUR STRING HAS BEEN REJECTED !!

                        ================================================================================================================
(base) niyatigupta@Maccy 2020BCSE073 %
```

LAB: 06

Aim: Write a program to construct operator precedence parsing table for the given grammar and check the validity of the input string (id+id*id).

E -> E+T | T

T-> T*F | F

F-> (E) | id

Code:

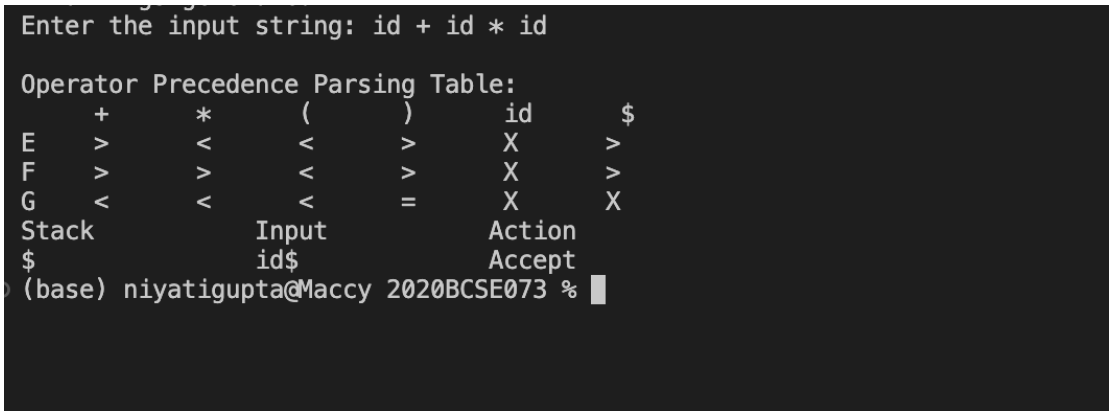
```
#include <stdio.h>
#include <string.h>
#define NUM_TERMINALS 6
#define NUM_NON_TERMINALS 3
#define MAX_LENGTH 50// Function to check if a character is an operator
int isOperator(char ch) {
   return (ch == '+' || ch == '*' || ch == '(' || ch == ')' || ch == 'id' || ch == '$');
}
// Function to get the precedence of an operator
char getPrecedence(char op) {
   switch (op) {
      case '+':
         return 1;
      case '*':
         return 2;
      case '(':
      case ')':
      case 'id':
      case '$':
         return 0;
      default:
         return -1; // Error
   }
}
```

```
// Function to initialize the operator precedence parsing table
void initializeTable(char table[][NUM_TERMINALS]) {
    // Terminals: +, *, (, ), id, $
    // Non-terminals: E, T, F
    // Initialize the table with X (no entry)
    for (int i = 0; i < NUM_NON_TERMINALS; i++) {
        for (int j = 0; j < NUM_TERMINALS; j++) {
            table[i][j] = 'X';
        }
    }
    // Fill in the entries based on the grammar
    table[0][0] = '>';  // E + T
    table[0][1] = '<';  // E * T
    table[0][2] = '<';  // E ( E )
    table[0][3] = '>';  // E id
    table[0][5] = '>';  // E $
    table[1][0] = '>';  // T + F
    table[1][1] = '>';  // T * F
    table[1][2] = '<';  // T ( E )
    table[1][3] = '>';  // T id
    table[1][5] = '>';  // T $
    table[2][0] = '<';  // F + T
    table[2][1] = '<';  // F * T
    table[2][2] = '<';  // F ( E )
    table[2][3] = '=';  // F id
    table[2][4] = 'X';  // F $
}

// Function to perform operator precedence parsing
int operatorPrecedenceParsing(char input[], char table[][NUM_TERMINALS]) {
    char stack[MAX_LENGTH];
```

```
int top = -1;

// Push a dollar sign onto the stack
stack[++top] = '$';

// Append a dollar sign to the end of the input
strcat(input, "$");

// Initialize the input pointer and stack symbol
int ip = 0;
char stackTop = stack[top];

printf("Stack\t\tInput\t\tAction\n");

while (stackTop != '$') {
   // Print the current stack and input
   printf("%-10s\t%-15s\t", stack, &input[ip]);

   // Check if the stack top and input symbol have the same precedence
   if (getPrecedence(stackTop) >= getPrecedence(input[ip])) {
      printf("Reduce ");
      // Simulate reducing based on precedence
      // This step is simplified for the given grammar
      top--;
   } else {
      printf("Shift ");
      // Simulate shifting the input symbol onto the stack
      stack[++top] = input[ip++];
   }

   // Move to the next line
   printf("\n");
```

```
        // Update the stack top
        stackTop = stack[top];
    }
    // Print the final action
    printf("%-10s\t%-15s\tAccept\n", stack, &input[ip]);
    return 0;
}
int main() {
    char input[MAX_LENGTH];
    char parsingTable[NUM_NON_TERMINALS][NUM_TERMINALS];
    // Input string: "id+id*id"
    printf("Enter the input string: ");
    scanf("%s", input);
    // Initialize and print the operator precedence parsing table
    initializeTable(parsingTable);
    printf("\nOperator Precedence Parsing Table:\n");
    printf("    +     *     (     )     id     $\n");
    for (int i = 0; i < NUM_NON_TERMINALS; i++) {
        printf("%c  ", 'E' + i);
        for (int j = 0; j < NUM_TERMINALS; j++) {
            printf("  %c    ", parsingTable[i][j]);
        }
        printf("\n");
    }
    // Perform operator precedence parsing
    operatorPrecedenceParsing(input, parsingTable);
    return 0;
}
```

Output:


Enter the input string: id + id * id
Operator Precedence Parsing Table:
+ * ( ) id $
E > < < > X >
F > > < > X >
G < < < = X X
Stack Input Action
$ id$ Accept
(base) niyatigupta@Maccy 2020BCSE073 %

LAB: 07

Aim: Write a program to implement recursive decent parser

Code:

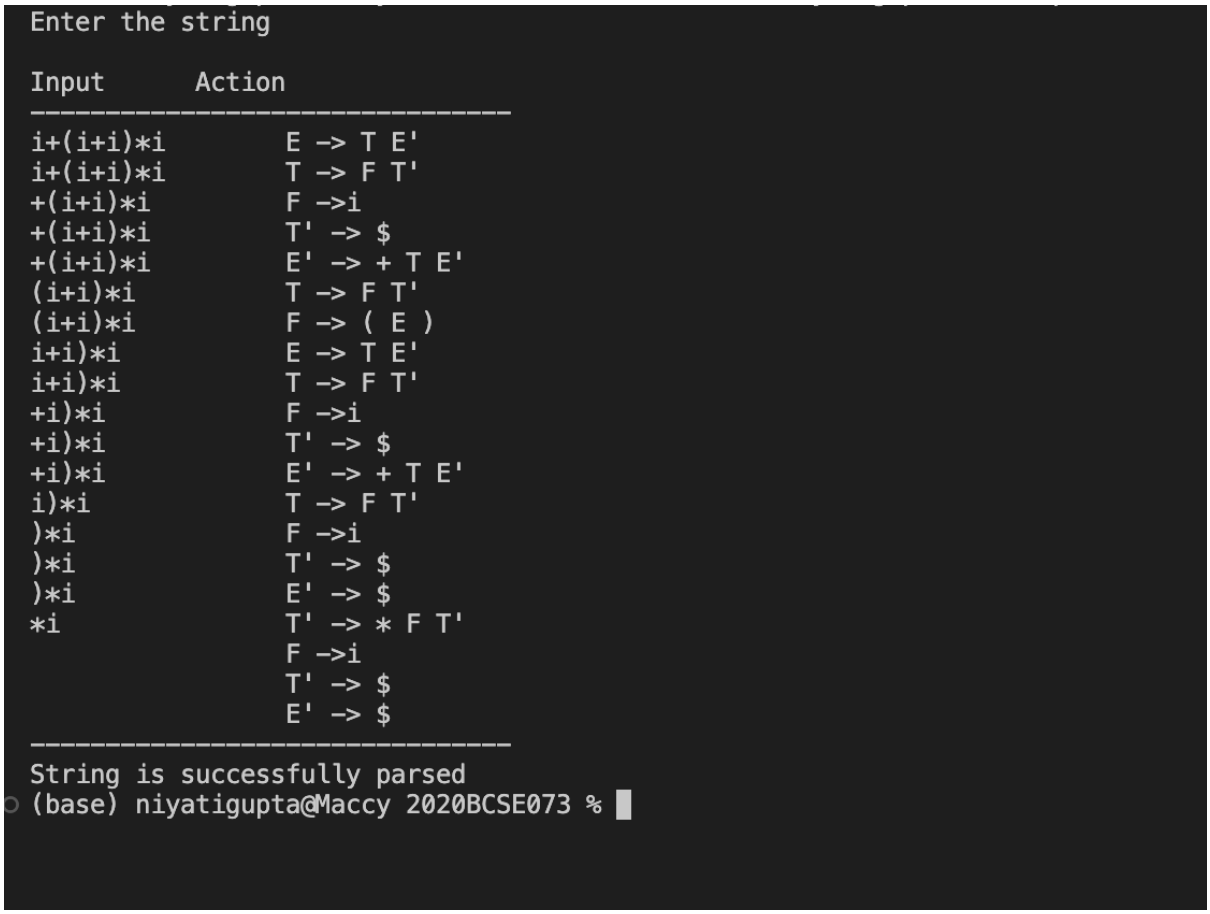
```
#include <stdio.h>
#include <string.h>
#define SUCCESS 1
#define FAILED 0
int E(), Edash(), T(), Tdash(), F();
const char *cursor;
char string[64];
int main()
{
   puts("Enter the string");
   // scanf("%s", string);
   sscanf("i+(i+i)*i", "%s", string);
   cursor = string;
   puts("");
   puts("Input      Action");
   puts("--------------------------------");
   if (E() && *cursor == '\0') {
      puts("--------------------------------");
      puts("String is successfully parsed");
      return 0;
   } else {
      puts("--------------------------------");
      puts("Error in parsing String");
      return 1;
   }
}

int E()
```

```
{
   printf("%-16s E -> T E'\n", cursor);
   if (T()) {
      if (Edash())
         return SUCCESS;
      else
         return FAILED;
   } else
      return FAILED;
}
int Edash()
{
   if (*cursor == '+') {
      printf("%-16s E' -> + T E'\n", cursor);
      cursor++;
      if (T()) {
         if (Edash())
            return SUCCESS;
         else
            return FAILED;
      } else
         return FAILED;
   } else {
      printf("%-16s E' -> $\n", cursor);
      return SUCCESS;
   }
}
int T()
{
   printf("%-16s T -> F T'\n", cursor);
   if (F()) {
      if (Tdash())
```

```
            return SUCCESS;
        else
            return FAILED;
    } else
        return FAILED;
}

int Tdash()
{
    if (*cursor == '*') {
        printf("%-16s T' -> * F T'\n", cursor);
        cursor++;
        if (F()) {
            if (Tdash())
                return SUCCESS;
            else
                return FAILED;
        } else
            return FAILED;
    } else {
        printf("%-16s T' -> $\n", cursor);
        return SUCCESS;
    }
}
 int F()
{
    if (*cursor == '(') {
        printf("%-16s F -> ( E )\n", cursor);
        cursor++;
        if (E()) {
            if (*cursor == ')') {
                cursor++;
```

```
            return SUCCESS;
        } else
            return FAILED;
    } else
        return FAILED;
} else if (*cursor == 'i') {
    cursor++;
    printf("%-16s F ->i\n", cursor);
    return SUCCESS;
} else
    return FAILED;
}
```

Output:


Enter the string
Input Action
i+(i+i)*i E -> T E'
i+(i+i)*i T -> F T'
+(i+i)*i F ->i
+(i+i)*i T' -> $
+(i+i)*i E' -> + T E'
(i+i)*i T -> F T'
(i+i)*i F -> (E)
i+i)*i E -> T E'
i+i)*i T -> F T'
+i)*i F ->i
+i)*i T' -> $
+i)*i E' -> + T E'
i)*i T -> F T'
)*i F ->i
)*i T' -> $
)*i E' -> $
*i T' -> * F T'
F ->i
T' -> $
E' -> $
String is successfully parsed
(base) niyatigupta@Maccy 2020BCSE073 %